Colorado River Regional Forum – Addendum

Changes/Corrections to the Colorado Hydrologic Region Report

Ecosystems

Several important ecosystems are in existence in the Colorado River Hydrologic Region. These are the Sonny Bono Salton Sea National Wildlife Refuge, the Wister Unit of the Imperial Wildlife Area, and a portion of the Mojave Desert Natural Reserve. These areas provide key habitat for both migratory and local birds and animals. Although progress has been slow, several environmental efforts related to the restoration of the Salton Sea are underway.

Salton Sea

Serving as wintering habitat for migratory and shoreline birds, ranging in number from hundreds of thousands to the low one million, are the Sonny Bono Salton Sea National Wildlife Refuge and the Wister Unit of the Imperial Wildlife Area. The SBSSNWR was established on the southern shores of the Salton Sea in 1998 in honor of the late U.S. Congressman's advocacy for environmental causes. It consists of 830 acres of land maintained as wetlands with an additional 870 acres planted to forage crops such as alfalfa, wheat, rye grass, and Sudan grass. The habitat was created for the endangered Yuma clapper rail and American Avocet. The WUIWA, located on the southeastern shore, occupies a little more than 7,900 acres of land. It includes salt marshes, freshwater ponds, and native, undeveloped lands.

The California Legislature enacted legislation in 2003 as part of the QSA/Transfer Agreements that directed the California Resources Agency (now the California Natural Resources Agency-CNRA) to prepare a restoration study and a programmatic environmental document to explore ways to restore important ecological functions of the Salton Sea (sea) and to develop a preferred restoration alternative. The Salton Sea Ecosystem Restoration Program Programmatic Environmental Impact Report (PEIR) was completed in 2007. The Secretary of the Resources Agency, based on the information contained in the PEIR, recommended to the Legislature a preferred alternative for ecosystem restoration with an estimated cost of over $9 billion and the creation of a Salton Sea Restoration Council. To date, the Legislature has not provided funding to implement the preferred alternative. In 2010, the Legislature enacted SB 51, which established the Salton Sea Restoration Council as a State entity under the CNRA to oversee the restoration of the Salton Sea (Ducheny). However, the Legislature has not yet appropriated funds for the council and is debating eliminating the council altogether.

This mitigation water is the subject of a new petition filed jointly by the IID and San Diego County Water Authority (SDCWA). The petition asks the SWRCB to eliminate the requirement for mitigation water from the year 2014 to 2017, unless the Legislature by 2014 adopts a comprehensive and fully funded plan to restore the Salton Sea. Rather than providing mitigation water, IID and SDCWA would implement what they call “accelerated alternative mitigation,” which aims to improve habitat even as it would reduce inflow to the Salton Sea. This would free up additional water to be transferred. The petition also asks the SWRCB to approve a schedule allowing transfer of that water currently reserved for the Salton Sea between 2014 and 2017.

Mojave Desert Natural Reserve

The southeastern portion of the Mojave Natural Preserve is located in the Twentynine Palms-Lanfair PA.

Despite arid conditions, a diverse collection of animals and plants have been able to settle and continue to flourish in the preserve. Natural seeps and springs are sufficient to support native vegetation, including yucca, creosote bush, cactus, relict white firs and chaparral, and the Joshua tree. The vegetation provides habitat to numerous animals and birds, including bighorn sheep, desert tortoises, hawks, and eagles.

Demographics

Although the Colorado River Hydrologic Region is known for its beautiful natural desert landscapes and major agricultural operations, it does have major urban centers in the Coachella and Imperial valleys. These centers have expanded for the past several decades to provide housing for the growing local population and large number of part-time residents who reside outside of the region, but take advantage of the tourism and outdoor recreation industries.

Population

Colorado River Hydrologic Region population in 2010 was 747,100. This is a 23 percent increase in population from 2000, but only a 5 percent increase from 2005. Slower growth in the last 5 years is a reflection of the serious impacts of the recession that started in September 2008. In 2010, about 83 percent of the population in the region was located in the Coachella Valley Planning Area (459,200 or 61 percent) and Imperial Valley PA (165,600 or 22 percent). Of the remaining 122,300 residents, the Twentynine Palms-Lanfair PA had 73,100.

In the Coachella Valley, many of the residents reside in golf- and resort- cities in the northwest portion of the valley. These include Cathedral City (2010 population - 51,200), Palm Desert (2010 population - 48,400), Palm Springs (2010 population - 44,600), Banning (2010 population - 29,600), and Desert Hot Springs (2010 population - 25,900). In the southeast, the cities provide more service support for the surrounding agricultural operations; included are Indio (2010 population - 76,000) and Coachella (2010 population - 40,700).

In the Imperial Valley, cities and towns provide support for the major agricultural and some energy industries, State prison, and Homeland Security operations throughout the area. Consumer services are also provided for residents and businesses located in the Mexicali Valley across the international border. Important cities include El Centro (2010 population - 42,600), Calexico (2010 population – 38,600), Brawley (2010 population – 24,950), and Imperial (2010 population – 14,800); and across the border in Mexico, the municipality of Mexicali (2012 population – 936,800). The community of Ocotillo (population 266) obtains water from the Ocotillo-Coyote Wells Groundwater Basin, an EPA-designated sole-source aquifer. Further development in that area is therefore not likely.

In Homestead and Coyote valleys in the Twentynine Palms-Lanfair PA, growing cities include Yucca Valley (2010 population – 20,700) and Twenty-nine Palms (2010 population – 25,068).

In the Colorado River PA, the City of Blythe (2010 population - 20,800) provides support for agricultural operations in the Palo Verde Valley. To the north is the City of Needles (2010 population – 4,800) in the Mohave Valley. Although there are no incorporated cities, the community of Winterhaven and widely dispersed residents in the Bard Valley, and west of Yuma, Arizona, represent about 3,200 permanent residents.

Tribal Communities

Native American Tribes with territory in the Colorado River region include the Agua Caliente Band of Cahuilla Indians, Augustine Band of Mission Indians (Cahuilla), Cabazon Band of Mission Indians, Chemehuevi Tribal Council, Fort Mojave Tribe, Morongo Band of Mission Indians, Torres-Martinez Band of Desert Cahuilla Indians, and the Twenty-Nine Palms Band of Mission Indians. In the Coachella Valley, tribal land alternates with those that are publicly and privately owned. One-mile square tribal parcels alternate with one-mile square municipal parcels.

A Native American tribe may be federally recognized, and the federal government may set aside lands for tribes as reservations. In California, these reservations are often named “Rancherias.” One interpretation of the Spanish term Rancheria is small Indian settlement. Granted tribal lands are listed in Table CR-8.

PLACEHOLDER Table CR-8 Granted Tribal Lands with Acreage, Colorado River Hydrologic Region

Disadvantaged Communities

The State defines a disadvantaged community (DAC) by using the median household income (MHI). A community is disadvantaged if MHI is less than 80 percent of the statewide median household income. A severely disadvantaged community (SDAC) is a community with a median household income less than 60 percent of the statewide median. According to the 2010 Census data, the California statewide MHI was $60,883. Thus, county subdivisions, census-designated places, and cities with an MHI of $48,706 or less are determined to be DACs. Those county subdivisions, census-designated places, and cities with an MHI of $36,530 or less are considered SDACs.

Imperial Valley Region

An evaluation of 2010 Census data determined the DACs within the Imperial Valley region. The MHI in the Imperial region was $36,202 according to U.S. Census Bureau estimates for 2010.

Although the City of Imperial does not meet the definition of a DAC, all other communities in this region have MHIs below the threshold of 80 percent of the statewide MHI ($48,706). Of the 19 locations in this region, 18 meet the definition of a DAC. Of those 18 DACs, 10 meet the definition of a SDAC.

To comply with EPA requirements and avoid termination of canal water service, residents in the IID service area who do not receive treated water service must obtain alternative water service for drinking and cooking from a State-approved provider. To avoid penalties that could exceed $25,000 a day, IID strictly enforces this rule.

Other than residents in Ocotillo, who access a sole source aquifer, virtually no one in the Imperial region has wells for domestic use. That is because of the high salinity of the groundwater. There are a few wells in the East Mesa that serve as sources for irrigation water.

Coachella Valley Region

In the Coachella Valley region, DAC issues are related to water, sewer and stormwater. Many rural mobile home communities that house the Coachella Valley’s significant farm and service industry labor force do not have access to public water and sewer infrastructure. The cost to extend public infrastructure to these communities is estimated to be above the $20 million. Funding of that magnitude has been unavailable. The private sewer infrastructure serving these communities is often undersized or otherwise failing. The private wells serving these communities often lack treatment infrastructure needed for removal of naturally occurring contaminants like arsenic. Identifying the locations and magnitude of these communities is also challenging due to language barriers, fear of government, and access to private land. Regional flood control facilities are not in place because the cost to build them exceeds the monetary value of the community infrastructure needing protection. The Coachella Valley Region Water Management Group (CVRWMG) is working to identify and implement lower-cost, near-term solutions that may be implemented with available grant funds thus improving these conditions in the interim period until permanent infrastructure can be funded.

Mojave Region

In the Mojave region, theMHI was $50,636 according to 2010 Census data. However, many areas within the region are disadvantaged. In the Colorado River Hydrologic Region-portion of the Mojave region, the MHI was $42,604; in the South Lahontan Hydrologic Region-portion of the Mojave region, the MHI was $52,021. Most of the rural, outlying areas in this region are considered DACs, but some of the more developed, urban areas are not. Four of the six incorporated cities in the region are DACs, but the City of Victorville and Town of Apple Valley are not.

Many of the small water systems serving rural disadvantage communities need improvements to increase their reliability, including ongoing maintenance and system deterioration problems, leak repairs, water storage reservoirs or other infrastructure to meet fire flow and outage needs, and other issues. Most of these systems do not have the staffing levels or expertise to pursue outside funding for projects that would address these problems. The region is developing a program that would help connect these systems with available State or federal funding.

Other Communities

The City of Blythe, by State standards, is a DAC. According to the 2010 Census, its MHI is $46,235, which is less than 75 percent of the California MHI. Because of the limited household income, the water-related rates, fees, and assessments are extremely difficult for individuals to absorb within their personal budgets. Water infrastructure is deteriorating to a point that could adversely affect public health. The city also suffers from the transient nature of its population, largely attributed to the State prisons within the community.

Other communities that have include DACs are Borrego Springs, Salton City, Bombay Beach, Palo Verde, Blythe, and Winterhaven.

Water Supplies

The Colorado River and groundwater are the primary water supply sources for the Colorado River Hydrologic Region. Most of the agricultural, urban, and environmental water demands are met with them. Some supplies from the SWP are delivered to the northern portion of the region through an exchange between the Coachella Valley Water District, Desert Water Agency, and the Metropolitan Water District of Southern California.

Surface Water Supply

Urban, agricultural, environmental, and energy water demands in the Colorado River Hydrologic Region are met with surface water supplies from the Colorado River, groundwater, and recycled water. Water supplies from the Colorado River meet all or portions of the agricultural and urban water demands in the

Imperial, Palo Verde, Coachella, and Bard valleys. The PVID operates facilities that divert water supplies from the Colorado River for its agricultural customers. For the Bard Valley, Colorado River water supplies are diverted to the area through the Yuma Project facilities, which are operated by the USBR. Colorado River water supplies are transported to the IID through the All-American Canal for its agricultural customers and for the urban customers of the public- and investor-owned water agencies in the valley. The recently concrete-lined Coachella Canal transports river water, taken at Drop 1 along the All-American Canal, into the Coachella Valley for agricultural and some urban uses. The Colorado River is an interstate and international river with use apportioned among the seven Colorado River Basin states and Mexico by a complex body of statutes, decrees, and court decisions known collectively as the "Law of the River" (see under Water Governance later in this section, "Regional Resource Management Conditions, Table CR-19 Key Elements of the Law of the River, Table CR-20 Annual Intrastate Apportionment of Water from the Colorado River Mainstream within California under the Seven Party Agreement, and Table CR-21 Annual Apportionment of Use of Colorado River Water Interstate/International).

Total water supplies required to meet the demands in the region between 2006 and 2010 ranged from 4,400 taf to 4,924 taf. Over 75 percent of the totals for each year were met by Colorado River supplies. These supplies were utilized in the following areas, Imperial Valley, Coachella Valley, Colorado River, and Borrego. (See Figure CR-9 Regional Inflows and Outflows, Colorado River Hydrologic Region.)

PLACEHOLDER Figure CR-9 Regional Inflows and Outflows, Colorado River Hydrologic Region

The State Water Project and recycled and local surface water supplies provide the remainder of water to the region. SWP supplies are obtained through an exchange agreement between the Coachella Valley Water District (CVWD), Desert Water Agency (DWA), and MWDSC. No facilities exist today to deliver SWP supplies to the Coachella Valley contractors. However, through the agreement, the MWDSC releases the combined SWP allocations for the CVWD and DWA into the Whitewater River from its Colorado River Aqueduct. These releases recharge the upper groundwater basin of the Coachella Valley and the Slission Creek groundwater basin. In exchange, MWDSC receives the two agencies' annual allocations through SWP facilities. The CVWD treats urban wastewater flows and makes the recycled water supplies available for non-potable uses such as irrigations of golf courses.

The CVWD and DWA continue work with water agencies outside of the region to augment its SWP deliveries and assist with local groundwater management activities. In addition to the advanced delivery of Colorado River water, CVWD, DWA, and MWDSC agreed to the terms of a second agreement, the 2003 Exchange Agreement. MWDSC transferred 100 taf of its SWP allocation to both agencies: 89 taf to CVWD, and 11 taf to DWA. In 2007, the agencies agreed to transfer agreements with the Berenda Mesa Water District and the Tulare Lake Water Basin Storage District for the transfer of additional SWP supplies; for 16 taf and 7 taf respectively. CVWD has also entered into agreements for the one-time transfer of non-SWP water supplies to its service area with the Rosedale-Rio Bravo Water Storage District, for banked Kern River flood waters and DMB Pacific, Inc. for "nickel" water from the Kern County Water Agency's Kern River Restoration and Water Supply Program.

Water Balance Summary

The water balances in the Colorado River Hydrologic Region are compiled by detailed analysis unit/county and then rolled up into the six planning areas in the region. There are no instream requirements or wild and scenic rivers in this hydrologic region. Managed wetlands exist in only one planning area (Imperial Valley, PA 1006). (See Figure CR-13 and Table CR-13 for depiction and data of regional water balance summary.)

PLACEHOLDER Figure CR-13 Colorado River Hydrologic Region Water Balance Summary by Water Year, 2001-2010

PLACEHOLDER Table CR-13 Colorado River Hydrologic Region Water Balance Summary, 2001-2010

Between 2006 and 2010, total water supplies for the Colorado River Hydrologic Region ranged from a high of 4,924 taf and 4,400 taf. About 70 percent of the water supplies needed annually were from the Colorado River and about 10 percent from local groundwater supplies. The Coachella and Twentynine Palms Lanfair areas received some SWP supplies during the period for groundwater recharge operations. The only planning area with reported use of recycled water supplies was the Coachella PA.

Palms-Lanfair (PA 1001) lies almost exclusively in San Bernardino County and is the northwestern-most planning area in the region. The urban applied water demands ranged between 18 and 22 taf annually; agricultural demans were 10 and 12 taf. Groundwater supplies were used to meet all demands. The SWP water supplies delivered to the area were used for groundwater recharge.

The Coachella Planning Area (PA 1002) is the most populated area in the hydrologic region. Urban demands ranged between 420 and 570 taf and were mostly met with groundwater and recycled water supplies and some Colorado River water uses in the southern end of the area. These demands continued to be significantly influenced by the high exterior water uses in the area. A large number of private and public golf courses and residential housing have been constructed over the past three decades to take advantage of the interests in outdoor recreation and retirees from outside of the area seeking to move into the area. Agricultural demands ranged between a low of 267 taf and a high of 291 taf and were met through a combination of Colorado River and groundwater supplies.

The area also received varying amounts from the SWP, from 1 to 172 taf. Tthe low amounts reflect the statewide drought. The supplies were obtained through the exchange agreement that the CVWD and Desert Water Agency have with the Metropolitan Water District of Southern California. This water supply was used exclusively for groundwater recharge.

Urban and agricultural land uses continued to be very small in the Chuckwalla Planning Area (PA 1003), and this is reflected in the very small annual demands during the period. Urban uses were a little more than 2 taf, and agricultural demands were closer to 3 taf. Groundwater supplies met most of these demands. and an agreement with the MWDSC brings a small quantity of Colorado River supplies into the Chiriaco Summit, just at the east of the Coachella Valley.

The Colorado River Planning Area (PA 1004) is the easternmost planning area in the Colorado River Hydrologic Region and continues to be dominated by agricultural demands. The urban water uses were steady, averaging between 13 to 14 taf, and were met with groundwater supplies. In contrast, the annual agricultural demands ranged between 586 and 749 taf with most being met with Colorado River water supplies. The lower demands is a reflection of the long-term land fallowing program between the Palo Verde Irrigation District and MWDSC.

The Borrego Planning Area (PA 1005) has less urban and agricultural applied water than PA 1004. Urban applied water ranged between 7 and 9 taf for the period. Agricultural demands ranged between 43 taf and a little less than 46 taf. A significant portion of the agricultural demands occurs in that portion of the planning area that lies in the Imperial Valley. About 40 percent of the supplies come from groundwater; and 60 percent from the Colorado River.

The Imperial Valley Planning Area (PA 1006) is another area dominated by agricultural demands. It also has the greatest agricultural demands and second highest urban demands in the hydrologic region and the highest agricultural use. Urban use ranges from 85 to 88 taf, a little more than half being used for energy production (geothermal facilities). Annual agricultural applied water demands ranged between 2,400 to 2,700 taf with an additional 650 to 700 taf evaporating or seeping into the ground during conveyance. This planning area also contains the only managed wetlands in the Colorado River Hydrologic Region which consumed about 30 taf of water annually.

Most of the urban, agriculture, and environmental water demands in the Imperial Valley PA were met with Colorado River water supplies. Some of the supplies are actually return flows from the agricultural operations in Colorado River PA.

Future Water Demand

In this section a description is provided for how future Colorado River Hydrologic Region water demands might change under scenarios organized around themes of growth and climate change described earlier. The change in water demand in the Colorado River region from 2006 to 2050 is estimated for agriculture and urban sectors under 9 growth scenarios and 13 scenarios of future climate change. The climate change scenarios included the 12 Climate Action Team scenarios described earlier and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a "without climate change" condition.

Change is depicted in box plots. A box plot is a graphical representation showing the minimum, 25th percentile, median, 75th percentile, and maximum values. The red dot shows the mean or average value. The change in water demand is the difference between the historical average for 1998 to 2005 and future average for 2043 to 2050.

Urban Demand

Figure CR-16 shows a box plot of change in urban water demand under 9 growth scenarios for the Colorado River region with variation shown across 13 scenarios of future climate including one scenario representing a repeat of the historical climate. Urban demand is the sum of indoor and outdoor water demand where indoor demand is assumed not to be affected by climate. Outdoor demand, however, is dependent on climate factors like amount of precipitation falling and the average air temperature. Urban demand increased under all 9 growth scenarios tracking with population growth. On average, it increased by about 440 taf under the three low population scenarios, 690 taf under the three current trend population scenarios, and about 940 taf under the three high population scenarios when compared to historical average of about 490 taf. The results show change in future urban water demands are less sensitive to housing density assumptions or climate change than to assumptions about future population growth.

PLACEHOLDER Figure CR-16 Change in Urban Water Demand

Agricultural Demand

Figure CR-17 shows a box plot of statewide change in agricultural water demand in the Colorado River Region under 9 growth scenarios with variation shown across 13 scenarios of future climate including one scenario representing a repeat of the historical climate. Agricultural water demand decreases under all future scenarios due to reduction in irrigated lands as a result of urbanization and background water conservation when compared with historical average water demand of about 3,490 taf. Under the three low population scenarios, the average reduction in water demand was about 1,630 taf while it was about 1,700 taf for the three high population scenarios. For the three current trend population scenarios, this change was about 1,660 taf. The results show that low density housing would result in more reduction in agricultural demand since more lands are lost under low-density housing than high density housing.

PLACEHOLDER Figure CR-17 Change in Agricultural Water Demand

Integrated Water Management Plan Summaries

Inclusion of the information contained in IRWMP's into the Water Plan regional reports has been a common suggestion by regional stakeholders at the regional outreach meetings since the inception of the IRWM program. To this end, the California Water Plan update has taken on the task of summarizing readily available Integrated Water Management Plan in a consistent format for each of the regional reports. This collection of information will not be used to determine IRWM grant eligibility. his effort is ongoing and will be included in the final Water Plan updates and will include up to four pages for each IRWMP in the regional reports.

In addition to these summaries being used in the regional reports we intend to provide all of the summary sheets in one IRWMP Summary "Atlas" as an article included in Volume 4. This atlas will, under one cover, provide an "at-a-glance" understanding of each IRWM region and highlight each region's key water management accomplishments and challenges. The atlas will showcase how the dedicated efforts of individual regional water management groups (RWMGs) have individually and cumulatively transformed water management in California.

All IRWMPs are different in how they are organized. Therefore, finding and summarizing the content in a consistent way proved difficult. It became clear through these efforts that a process is needed to allow those with the most knowledge of the IRWMPs — those who were involved in the preparation — to have input on the summary. It is the intention that this process be initiated following release of Water Plan Update 2013 and will continue to be part of the process of the update process for California Water Plan Update 2018. This process will also allow for continuous updating of the content of the atlas as new IRWMPs are released or existing IRWMPs are updated.

As can be seen in Figure CR-18, there are 4 IRWM planning efforts ongoing in the San Joaquin River Hydrologic Region.

PLACEHOLDER Figure CR-18 Integrated Water Management Planning in Colorado River Hydrologic Region

Placeholder Text: At the time of the Public Review Draft the collection of information out of the IRWMPs in the region has not been completed. Below are the basic types of information this effort will summarize and present in the final regional report for each IRWMP available. An opportunity will be provided to those with responsibility over the IRWMP to review these summaries before the reports are final.

Region Description: This section will provide a basic description of the IRWM region. This would include location, major watersheds within the region, status of planning activity, and the governance of the IRWM. In addition, a IRWM grant funding summary will be provided.

Key Challenges: The top five challenges identified by the IRWM would be listed in this section.

Principal Goals/Objective: The top five goals and objectives identified in the IRWMP will be listed in this section.

Major IRWM Milestones and Achievements: Major milestones (Top 5) and achievements identified in the IRWMP would be listed in this section.

Water Supply and Demand: A description (one paragraph) of the mix of water supply relied upon in the region along with the current and future water demands contained in the IRWMP will be provided in this section.

Flood Management: A short (one paragraph) description of the challenges faced by the region and any actions identified by the IRWMP will be provided in this section.

Water Quality: A general characterization of the water quality challenges (one paragraph) will be provided in this section. Any identified actions in the IRWMP will also be listed.

Groundwater Management: The extent and management of groundwater (one paragraph) as described in the IRWMP will be contained in this section.

Environmental Stewardship: Environmental stewardship efforts identified in the IRWMP will be summarized (one paragraph) in this section.

Climate Change: Vulnerabilities to climate change identified in the IRWMP will be summarized (one paragraph) in this section.

Tribal Communities: Involvement with tribal communities in the IRWM will be described (one paragraph) in this section of each IRWMP summary.

Disadvantaged Communities: A summary (one paragraph) of the discussions on disadvantaged communities contained in the IRWMP will be included in this section of each IRWMP summary.

Governance: This section will include a description (less than one paragraph) of the type of governance the IRWM is organized under.

Resource Management Strategies

Volume 3 contains detailed information on the various strategies which can be used by water managers to meet their goals and objectives. A review of the resource management strategies addressed in the available IRWMPs are summarized in Table CR-28.

PLACEHOLDER Table CR-28 Resource Management Strategies addressed in IRWMP's in the Colorado River Hydrologic Region

Regional Resource Management Strategies

Drinking Water Treatment & Distribution

Conjunctive Management and Groundwater Storage

Conjunctive management, or conjunctive use, refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Managing both resources together, rather than in isolation, allows water managers to use the advantages of both resources for maximum benefit. Additional information regarding conjunctive management in California as well as discussion on associated benefits, costs, and issues can be found online from *Water Plan Update 2013 Vol. 3 Ch. 9 Conjunctive Management and Groundwater Storage Resource Management Strategy*.

A survey undertaken in 2011-2012 jointly by DWR and ACWA to inventory and assess conjunctive management projects in California is summarized in Box CR-3. More detailed information about the survey results and a statewide map of the conjunctive management projects and operational information, as of July 2012, is available online from *Water Plan Update 2013 Vol. 4 Reference Guide – California's Groundwater Update 2013.*

PLACEHOLDER Box CR-3 Statewide Conjunctive Management Inventory Effort in California

Conjunctive Management Inventory Results

Of the 89 conjunctive management programs identified in California, only one program is located in the Colorado River Hydrologic Region. The program consists of a direct groundwater percolation program started in 1991 with Mojave Water Agency identified as the lead agency and the administrator/operator of the project. The goals and objectives of this conjunctive management program are to address groundwater overdraft correction. Annual recharge and extraction amounts vary year to year. Current recharge and extraction capacity is estimated at 50,000 acre-feet per year, while the cumulative recharge capacity is estimated at 390,000 acre-feet. Efforts are underway to increase program capacity. The SWP was identified as the source of program water. Current operating cost for the program is estimated at $900,000 per year. Project cost was identified as the most significant constraint for the program. Limited aquifer storage was determined to be a moderate constraint, while other constraints include political, legal, institutional, and water quality issues.

Climate Change

For over two decades, the State and federal governments have been preparing for climate change effects on natural and built systems with a strong emphasis on water supply. Climate change is already impacting many resource sectors in California, including water, transportation and energy infrastructure, public health, biodiversity, and agriculture (U.S. Global Change Research Program 2009; California Natural Resources Agency 2009). Climate model simulations, based on the Intergovernmental Panel on Climate Change's 21st century scenarios, project increasing temperatures in California, with greater increases in the summer. Projected changes in annual precipitation patterns in California will result in changes to surface runoff timing, volume, and type (Cayan 2008). Recently developed computer downscaling techniques indicate that California flood risks from warm-wet, atmospheric river type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011).

Currently, enough data exist to warrant the importance of contingency plans, mitigation (i.e., reduction) of greenhouse gas (GHG) emissions, and incorporating adaptation strategies (i.e., methodologies and infrastructure improvements that benefit the region at present and into the future). While the State of California is taking aggressive action to mitigate climate change through reducing emissions from GHGs and implementing other measures (California Air Resources Board 2008), global impacts from carbon dioxide and other GHGs that are already in the atmosphere will continue to impact climate through the rest of the century (Intergovernmental Panel on Climate Change 2007.

Resilience to an uncertain future can be achieved by implementing adaptation measures sooner rather than later. Because of the economic, geographical, and biological diversity of California, vulnerabilities and risks from current and future anticipated changes are best assessed on a regional basis. Many resources are available to assist water managers and others in evaluating their region-specific vulnerabilities and identifying appropriate adaptive actions (U.S. Environmental Protection Agency and California Department of Water Resources 2011; California Emergency Management Agency and Californai Natural Resources Agency 2012a).

Observations

The region’s observed temperature and precipitation vary greatly due to complex topography. Regionally specific temperature observations can be retrieved through the Western Regional Climate Center (WRCC). Locally in the Colorado River region within the WRCC Sonoran Desert climate region, mean temperatures have increased by about 0.9 to 2.0 °F (0.5 to 1.1 °C) in the past century, with minimum and maximum temperatures increasing by about 1.6 to 2.7 °F (0.9 to 1.5 °C) and by 0.2 to 1.5 °F (0.1 to 0.8 °C), respectively (Western Regional Climate Center 2012). Within the WRCC Mojave Desert climate region, mean temperatures have increased by about 1.2 to 2.4 °F (0.7 to 1.3 °C) in the past century, with minimum and maximum temperatures increasing by about 1.5 to 2.6 °F (0.8 to 1.4 °C) and by 0.9 to 2.3 °F (0.5 to 1.3 °C), respectively (Western Regional Climate Center 2012).

The Colorado River region also is experiencing impacts from climate change through changes in statewide precipitation and surface runoff volumes, which in turn affect availability of local and imported water supplies. During the last century, the average early snowpack in the Sierra Nevada, which is an important source of water for parts of the Colorado River region through the SWP, decreased by about 10 percent, which equates to a loss of 1.5 maf of snowpack storage (California Department of Water Resources 2008).

Water supplies coming from the Colorado River Basin outside California are also decreasing (California Natural Resources Agency 2009). Similar climate effects, although much more variable, are occurring in the Rocky Mountains snowpack that supplies the Colorado River, another important source of water for the Colorado River region (Christensen et al. 2004; Mote et al. 2005; Williamson et al. 2008; Guido 2008). Even though variability exists in the snowpack levels of the Rocky Mountains and spatial patterns of trends are not consistent, streamflows in the Colorado River appear to be peaking earlier in the year (Stewart et al. 2005; Garfin 2005), and the average water yield of the Colorado River could be reduced by 10 to 20 percent due to climate change (U.S. Bureau of Reclamation 2011).

Sea level rise, although not a direct impact to the Colorado River region, degrades the quality of the region's imported water from the Sacramento-San Joaquin River Delta, as well as increases salinity intrusion and impacts the Delta levee infrastructure, requiring substantial capital investments by the public. According to the California Climate Change Center, sea level rose 7 inches (18 cm) along California's coast during the past century (California Department of Water Resouces 2008; California Natural Resources Agency 2009).

Projections and Impacts

While historical data is a measured indicator of how the climate is changing, it cannot project what future conditions may be like under different GHG emissions scenarios. Current climate science uses modeling methods to simulate and develop future climate projections. A recent study by Scripps Institution of Oceanography uses the most sophisticated methodology to date and indicates that by 2060-2069, temperatures will be 3.4 - 4.9 °F (1.9 -2.7 °C) higher across the state than they were from 1985 to1994 (Pierce et al. 2012). By 2060-29, the annual mean temperature will increase by 4.7 °F (2.6 °C) for the WRCC Sonoran Desert climate region, with increases of 3.6 °F (2.0 °C) during the winter months and 5.4 °F (3.0 °C) during summer. The WRCC Mojave Desert climate region has similar projections with annual mean temperatures increasing by 4.9 °F (2.7 °C), winter temperatures increasing by 3.6 °F (2.0 °C), and summer temperatures increasing by 5.9 °F (3.3 °C) (Pierce et al. 2012). Climate projections from Cal-Adapt indicate that the temperatures between 1990 and 2100 are projected to increase about 5 to 8 °F (2.8 to 4.4 °C) during winter and up to 6 to 9 °F (3.3 to 5.0 °C) during summer (California Emergency Management Agency and California Natural Resources Agency 2012b).

Changes in annual precipitation across California, either in timing or total amount, will result in changes to the type of precipitation (rain or snow) in a given area and to the timing and volume of surface runoff. Precipitation projections from climate models for California are not all in agreement, but most anticipate drier conditions in the southern part of California, with heavier and warmer winter precipitation in the north (Pierce et al. 2012). Because there is less scientific detail on localized precipitation changes, there exists a need to adapt to this uncertainty at the regional level (Qian et al. 2010).

The Sierra Nevada snowpack, a source of water through the SWP, is expected to continue to decline as warmer temperatures raise the elevation of snow levels, reduce spring snowmelt, and increase winter runoff. Basing upon historical data and modeling, researchers at Scripps Institution of Oceanography project that, by the end of this century, the Sierra snowpack will experience a 48 to 65 percent loss from its average at the end of the previous century (van Vuuren et al. 2011). In addition, earlier seasonal flows will reduce the flexibility in how the state manages its reservoirs to protect communities from flooding while ensuring a reliable water supply.

Although annual precipitation will vary by area, reduced snow and precipitation in the Sierra Nevada range and the Colorado River basin will affect the imported water supply for the Colorado River region and cause potential overdrafting of the region's groundwater basins. Of California's 10 hydrologic regions, the Colorado River region has the lowest annual precipitation (California Department of Water Resources 2009). Projections for the Colorado River region indicate that the annual rainfall will decrease in the more urbanized areas, with the southern Imperial County getting about 0.5 inches (1.3 cm) of less rain and the more eastern desert areas seeing little change (California Emergency Management Agency and California Natural Resources Agency 2012b).

On the other hand, extremes in California's precipitation are projected to increase with climate change. Recent computer downscaling techniques indicate that California flood risks from warm-wet, atmospheric river-type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011). Winter runoff could result in flashier flood hazards. Higher flow volumes will scour stream and flood control channels, degrading habitats already impacted by shifts in climate and placing additional stress on special-status species. The lower deserts of the Colorado River region are susceptible to flooding, which is a concern in the Borrego and Coachella valleys. The Whitewater River has caused severe flooding back in 1965, 1969, and 1976 (California Department of Water Resources 2009). The occasional summer monsoonal thunderstorms that the lower deserts experience could increase in frequency and intensity and result in flash floods and debris flows, especially in areas with alluvial fans.

Changes in climate and runoff patterns may create competition among sectors that utilize water. The agricultural demand within the region could increase due to higher evapotranspiration rates caused by increased temperatures. Prolonged drought and decreased water quality could further diminish the viability of intermittent streams characteristic of this region and the Salton Sea, the state's largest lake. The Salton Sea is a critical stop for migratory birds on the Pacific and Central Flyways, and, as the lake's level declines and sediments currently underwater get exposed, birds and fish would be impacted and increased amounts of windborne dust could affect human health in the Coachella and Imperial valleys, as well as in Mexico (U.S. Geological Survey 2007; Pitzer 2013).

Environmental water supplies would need to be retained for managing flows in habitats for aquatic and migratory species throughout the dry season not only for the Salton Sea, but also for the region's imported water. Currently, Delta pumping restrictions are in place to protect endangered aquatic species. Climate change is likely to further constrain the management of these endangered species and the state's ability to provide water for other uses. For the Colorado River region, this would further reduce supplies available for import through the SWP during the non-winter months (Cayan 2008; Hayhoe 2004). The USBR Lower Colorado Region, which serves as the watermaster for the lower Colorado River, must also balance water supply with demand, including water-dependent ecological systems and habitats, hydroelectric generation, water quality, and recreation (U.S. Bureau of Reclamation 2011). USBR's Colorado River Basin Study confirms a range of potential future imbalances between water supply and water demand, as well as a need for an approach that applies a multitude of options at all levels to address such imbalances (U.S. Bureau of Reclamation 2012).

Prolonged drought events are likely to continue and further impact the availability of local and imported surface water and contribute to the depletion of groundwater supplies. With increasing temperatures, net evaporation from reservoirs is projected to increase by 15 to 37 percent (Medellin-Azuara et al. 2009; California Natural Resources Agency 2009). The Colorado River Basin is a critical source of water for the Colorado River region. Although the existing storage capacity for the Colorado River has provided the ability to meet water demands during sustained droughts, droughts of greater severity have occurred and will likely occur again in the future (U.S. Bureau of Reclamation 2011). According to the USBR, droughts lasting five or more years are projected to occur 50 percent of the time over the next 50 years (U.S. Bureau of Reclamation 2012).

Higher temperatures and decreased moisture during the summer and fall seasons, particularly in the mountain reaches of the lowland desert area, will increase vulnerability to wildfire hazards in the Colorado River region and impact local watersheds, though the extent to which climate change will alter existing risk to wildfires is variable (Westerling and Bryant 2006). Little change is projected for most of the region, except for the Mecca San Gorgonio and San Jacinto Mountains, which are likely to have one and half to two times more wildfires (California Emergency Management Agency and California Natural Resources Agency 2012b). However, early snowmelt and drier conditions will increase the size and intensity of these fires (Westerling 2012).

Furthermore, wildfires can contribute to debris flow flooding in vulnerable communities in the foothills of the Colorado River region. Past events have shown flooding to be a real concern after fires occur. The community of Borrego Springs was flooded in 2003 by stormwater runoff flowing from the Ranchita area that had earlier been scorched by fire (California Department of Water Resources 2009). The highly unpredictable nature of alluvial fans within a region can create flooding situations dependent on rain, vegetation, and wildfires (Stuart 2012).

A recent study that explores future climate change and flood risk in the Sierra, using downscaled simulations (refining computer projections to a scale smaller than global models) from three global climate models (GCMs) under an accelerating GHG emissions scenario that is more reflective of current trends, indicates a tendency toward increased three-day flood magnitude. By the end of the 21st century, all three projections yield larger floods for both the moderate elevation northern Sierra Nevada watershed and for the high elevation southern Sierra Nevada watershed, even for GCM simulations with 8 to15 percent declines in overall precipitation. The increases in flood magnitude are statistically significant for all three GCMs for the period 2051 to 2099. By the end of the 21st Century, the magnitudes of the largest floods increase to 110 to 150 percent of historical magnitudes. These increases appear to derive jointly from increases in heavy precipitation amount, storm frequencies, and days with more precipitation falling as rain and less as snow (Das et al. 2011)..

Even though this study focused on the Sierra, these scenarios could potentially be indicative of other regional settings already experiencing flooding risks. Therefore, it is essential for local agencies to take action and be ready to adapt to climate change to protect the well-being of local communities.

Adaptation

Changes in climate have the potential to impact the region, upon which the state depends for its economic and environmental benefits. These changes will increase the vulnerability of natural and built systems in the region. Impacts to natural systems will challenge aquatic and terrestrial species by diminishing water quantity and quality and shifting eco-regions. Built systems will be impacted by changing hydrology and runoff timing, loss of natural snowpack storage, making the region more dependent on surface storage in reservoirs and groundwater sources. Preparing for increased future water demand for both natural and built systems may be particularly challenging with less natural storage and less overall supply.

The Colorado River region contains a diverse landscape with different climate zones, making it difficult to find one-size-fits-all adaptation strategies. Water managers and local agencies must work together to determine the appropriate planning approach for their operations and communities. While climate change adds another layer of uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (U.S. Environmental Protection Agency and California Department of Water Resources 2011). However, stationarity (the concept that natural systems fluctuate within an unchanging envelope of variability) can no longer be assumed, so new approaches will likely be required (Milly, et al. 2008). Whatever planning approach is used, it is necessary for water managers and communities to start implementing adaptation measures sooner than later in order to be prepared for current and future changes.

IRWM planning is an example of a framework that allows water managers to address climate change on a smaller, more regional scale. Climate change is now a required component of all IRWM plans. IRWM regions must identify and prioritize their specific vulnerabilities to climate change, and identify the adaptation strategies that are most appropriate. Planning and adaptation strategies to that address the vulnerabilities should be proactive and flexible, starting with proven strategies that will benefit the region today and adding new strategies that will be resilient to the uncertainty of climate change.

Water supplies within California are already stressed because of current demand and expected population growth. Even though the Colorado River region represents about 2 percent of the state's population, it grew by 18 percent between 2000 and 2005 (California Department of Water Resources 2009). The uncertainty on the extent of these environmental changes will no doubt reduce the ability of local agencies to meet the water demand for the Colorado River region, if these agencies are not adequately prepared.

Adaptation strategies to consider for managing water in a changing climate include developing coordinated plans for mitigating future flood, landslide, and related impacts, implementing activities to minimize and avoid development in flood hazard areas, restoring existing flood control and riparian and stream corridors, implementing tiered pricing to reduce water consumption and demand, increasing regional natural water storage systems, and encouraging low impact development to reduce stormwater flows, and promoting economic diversity and supporting alternative irrigation techniques within the agriculture industry. To further safeguard water supplies, other promising strategies include adopting more water-efficient cropping systems, investing in water saving technologies, and developing conjunctive use strategies. In addition, tracking forest health in the mountain areas and reducing accumulated fuel load will provide a more resilient watershed ecosystem that can mitigate for floods and droughts. (California Department of Water Resources 2008; Hanak and Lund 2011; California Emergency Management Agency and California Natural Resources Agency 2012c; California Natural Resources Agency 2012; Jackson et al. 2012.)

Local, State, and federal agencies face the challenge of interpreting climate change data and determining which methods and approaches are appropriate for their planning needs. The Climate Change Handbook for Regional Water Planning provides an analytical framework for incorporating climate change impacts into a regional and watershed planning process and considers adaptation to climate change (U.S. Environmental Protection Agency and California Department of Water Resources 2011). This handbook provides guidance for assessing the vulnerabilities of California's watersheds and regions to climate change impacts, and prioritizing these vulnerabilities.

Central to adaptation in water management is full implementation of IRWM plans that address regionally appropriate practices that incorporate climate change adaptation. These IRWM plans, along with regional flood management plans, can integrate water management activities that connect corridors and restore native aquatic and terrestrial habitats to support the increase in biodiversity and resilience for adapting to changes in climate (California Natural Resources Agency 2009). However, with limited funds the regional water management groups (RWMGs) must prioritize their investments.

Already RWMGs in the Colorado River region are taking action. The Mojave RWMG is implementing projects that assist in adapting to climate change. The Mojave RWMG has facilitated water conservation projects and has received funding to complete a recharge project in the Joshua Basin. The Coachella Valley RWMG is integrating flood management and including a groundwater monitoring strategy into its IRWM plan update and has received implementation funds to treat arsenic in the water supply of DACs. Priorities for the Imperial Valley RWMG include protecting its sole-source aquifer in the Ocotillo area and managing groundwater to include desalination and storage.

Additional work is underway to better understand impacts of climate change and other stressors on water supply and demand for the Colorado River region. USBR has completed a basin study to define current and future imbalances in water supply and demand in the Colorado River Basin and the adjacent areas of the Basin States, including California, that receive Colorado River water (U.S. Bureau of Reclamation 2011; U.S. Bureau of Reclamation 2012). Through this study, USBR developed and analyzed adaptation and mitigation strategies to resolve those imbalances. Future actions must occur to implement these solutions; therefore, USBR is coordinating with the Basin States, Tribes, conservation organizations, and other stakeholders (U.S. Bureau of Reclamation 2012).

DWR is assisting the Anza-Borrego RWMG by documenting the past, present, and range of foreseeable future conditions within the local groundwater basins of the Borrego Valley and summarizing the information in an Anza-Borrego Desert Region Summary report. USBR also is collaborating with the Borrego Water District and other local water agencies in a basin study specific to California's Colorado River region to assess the effects of prolonged drought, population growth, and climate change, and to develop adaptation strategies for the region to handle future water supply and water quality demands (U.S. Bureau of Reclamation 2010).

The Salton Sea Species Conservation Habitat Project completed a draft EIS/EIR that discussed climate change impacts and provided an analysis of GHG emissions (U.S. Army Corps of Engineers and California Natural Resources Agency 2011), and the cities of Palm Desert and Palm Springs have conducted GHG emissions inventories and adopted GHG targets (DeShazo and Matute 2012). According to the Luskin Center for Innovation report, roughly one-third of Southern California cities have taken steps toward reducing GHG emissions (DeShazo and Matute 2012), but more work needs to be done, not only in mitigating for but also in adapting to climate change.

Strategies to manage local water supplies must be developed with the input of multiple stakeholders (Jackson et al. 2012). While both adaptation and mitigation are needed to manage risks and are often complementary and overlapping, there may be unintended consequences if efforts are not coordinated (California Natural Resources Agency 2009).

The Imperial Valley RWMG recognizes the disconnect between land use planning and water supply within its area and has brought land use representatives from Imperial County, local cities, and unincorporated towns into its IRWM membership in updating its IRWM plans and prioritizing its projects. A mitigation policy for cumulative impact of development within the region is one of the priorities for the Imperial Valley RWMG. Another example of integrating across sectors is a tool developed by the California State University at San Bernardino – Water Resources Institute developed in partnership with DWR, which is a web-based portal for land use planning in alluvial fans and uses an integrated approach in assessing hazards and resources (http://aftf.csusb.edu/; Lien-Longville 2012).The State of California has developed additional online tools and resources to assist water managers, land use planners, and local agencies in adapting to climate change. These tools and resources include the following:

- *2009 California Climate Adaptation Strategy* (http://resources.ca.gov/climate_adaptation/docs/Statewide_Adaptation_Strategy.pdf), which identifies a variety of strategies across multiple sectors (other resources can be found at http://www.climatechange.ca.gov/adaptation/strategy/index.html)
- *California Adaptation Planning Guide* (http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html), developed into four complementary documents by the Cal-EMA and the CNRA to assist local agencies in climate change adaptation planning
- *Cal-Adapt* (http://cal-adapt.org/), an online tool designed to provide access to data and information produced by California's scientific and research community
- *Urban Forest Management Plan Toolkit* (www.UFMPtoolkit.com), sponsored by the CALFIRE to help local communities manage urban forests to deliver multiple benefits, such as cleaner water, energy conservation, and reduced heat-island effects
- *California Climate Change Portal* (http://www.climatechange.ca.gov/)
- *DWR Climate Change* website (http://www.water.ca.gov/climatechange/resources.cfm)
- *The Governor's Office of Planning and Research* Web site (http://www.opr.ca.gov/m_climatechange.php)

There are several resource management strategies found in *Volume 3 of the California Water Plan Update 2013* that not only assist in meeting water management objectives but also provide benefits for adapting to climate change, including the following:

- Agricultural and Urban Water Use Efficiency
- Water Transfers
- Conjunctive Management and Groundwater Storage
- Desalination
- Recycled Municipal Water
- Surface Storage – Regional/Local
- Drinking Water Treatment and Distribution
- Groundwater/Aquifer Remediation
- Pollution Prevention
- Salt and Salinity Management
- Agricultural Land Stewardship
- Economic Incentives
- Ecosystem Restoration
- Forest Management
- Land Use Planning and Management

- Recharge Area Protection
- Watershed Management
- Integrated Flood Management

The myriad of resources and choices available to managers can seem overwhelming, and the need to take action given uncertain future conditions is daunting. There are many low-regret actions that water managers in the Colorado River region can take to prepare for climate change, regardless of the magnitude of future warming. These low-regret actions involve adaptation options where moderate levels of investment increase the capacity to cope with future climate risks (The World Bank 2012).

Water managers and others will need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystem services important for human society, such as flood management, carbon sequestration, pollution remediation, and recreation. Land use decisions are central components in preparing for and minimizing the impacts from climate change (California Natural Resources Agency 2009). Increased cross-sector collaboration among water managers, land use planners and ecosystem managers provides opportunities for identifying common goals and actions needed to achieve resilience to climate change and other stressors.

Mitigation

California's water sector has a large energy footprint, consuming 7.7 percent of statewide electricity (California Public Utilities Commission 2010). Energy is used in the water sector to extract, convey, treat, distribute, use, condition, and dispose of water. Figure 3-26, Water-Energy Connection in Volume 1, CA Water Today shows all of the connections between water and energy in the water sector; both water use for energy generation and energy use for water supply activities. The regional reports in the 2013 California Water Plan Update are the first to provide detailed information on the water-energy connection, including energy intensity (EI) information at the regional level. This EI information is designed to help inform the public and water utility managers about the relative energy requirements of the major water supplies used to meet deman. Since energy usage is related to Greenhouse Gas (GHG) emissions, this information can support measures to reduce GHG's, as mandated by the State.

Figure CR-19 shows the amount of energy associated with the extraction and conveyance of 1 acre-foot of water for each of the major sources in this region. The quantity used is also included, as a percent. For reference, Figure 3-26, Water-Energy Connection (in California Water Today chapter of the Water Plan's Volume 1) highlights which water-energy connections are illustrated in Figure CR-19; only extraction and conveyance of raw water. Energy required for water treatment, distribution, and end uses of the water are not included. Not all water types are available in this region. Some water types flow by gravity to the delivery location and therefore do not require any energy to extract or convey (represented by a white light bulb).

PLACEHOLDER Figure CR-19 Energy Intensity of Raw Water Extraction and Conveyance in the Colorado River Hydrologic Region

Recycled water and water from desalination used within the region are not show in Figure CR-19 because their energy intensity differs in important ways from those water sources. The energy intensity of both recycled and desalinated water depend not on regional factors but rather on much more localized, site, and application specific factors. Additionally, the water produced from recycling and desalination is typically of much higher quality than the raw (untreated) water supplies evaluated in Figure CR-19. For these reasons, discussion of energy intensity of desalinated water and recycled water are included in *Volume 3, Resource Management Strategies*.

Energy intensity, sometimes known as embedded energy, is the amount of energy needed to extract and convey (Extraction refers to the process of moving water from its source to the ground surface. Many water sources are already at ground surface and require no energy for extraction, but others like groundwater or sea water for desalination require energy to move the water to the surface. Conveyance refers to the process of moving water from a location at the ground surface to a different location, typically but not always a water treatment facility. Conveyance can include pumping of water up hills and mountains or can occur by gravity. An acre-foot of water from its source (e.g. groundwater or a river) to a delivery location, such as a water treatment plant or SWP delivery turnout Energy from low-head pump lifts (less than 50 feet) used to divert water out of river channels or canals has been excluded from the calculations. Energy intensity should not be confused with total energy—that is, the amount of energy (e.g. kWh) required to deliver all of the water from a water source to customers within the region. Energy intensity focuses not on the total amount of energy used to deliver water, but rather the energy required to deliver a single unit of water (in kWh/acre-foot). In this way, energy intensity gives a normalized metric which can be used to compare alternative water sources.

In most cases, this information will not be of sufficient detail for actual project level analysis. However, these generalized, region-specific metrics provide a range in which energy requirements fall. The information can also be used in more detailed evaluations using tools such as WeSim (http://www.pacinst.org/publication/wesim/), which allows modeling of water systems to simulate outcomes for energy, emissions, and other aspects of water supply selection. It is important to note that water supply planning must take into consideration a myriad of different factors in addition to energy impacts, costs, water quality, opportunity costs, environmental impacts, reliability and other many other factors.

Energy intensity is closely related to GHG emissions, but not identical, depending on the type of energy used (see Water Plan Volume 1, California Water Today, Water-Energy section). In California, generation of 1 megawatt-hour (MWh) of electricity results in the emission of about a third of a metric ton of GHG, typically referred to as carbon dioxide equivalent or CO_2e (eGrid 2012). (Go to http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2012V1_0_year09_GHGOutputrates.pdf.) This estimate takes into account the use of GHG-free hydroelectricity, wind, and solar and fossil fuel sources like natural gas and coal. The GHG emissions from a specific electricity source may be higher or lower than this estimate.

Reducing GHG emissions is a State mandate. Water managers can support this effort by considering energy-intensity factors, such as those presented here, in their decision-making process. Water use efficiency and related best management practices can also reduce GHGs (*See Volume 2, Resource Management Strategies*).

Accounting for Hydroelectric Energy

Generation of hydroelectricity is an integral part of many of the state's large water projects. In 2007, hydroelectric generation accounted for nearly 15 percent of all electricity generation in California. The SWP, Central Valley Project, Los Angeles Aqueduct, Mokelumne Aqueduct, and Hetch Hetchy Aqueducts all generate large amounts of hydroelectricity at large multi-purpose reservoirs at the heads of each system. In addition to hydroelectricity generation at head reservoirs, several of these systems also generate hydroelectric energy by capturing the power of water falling through pipelines at in-conduit generating facilities. (In-conduit generating facilities refer to hydroelectric turbines that are placed along pipelines to capture energy as water runs down hill in a pipeline, conduit.).). Hydroelectricity is also generated at hundreds of smaller reservoirs and run-of-the-river turbine facilities.

Hydroelectric generating facilities at reservoirs provide unique benefits. Reservoirs like the SWP's Oroville Reservoir are operated to build up water storage at night when demand for electricity is low, and release the water during the daytime hours when demand for electricity is high. This operation, common to many of the state's hydropower reservoirs, helps improve energy grid stabilization and reliability and reduces GHG emissions by displacing the least efficient electricity generating facilities. Hydroelectric facilities are also extremely effective for providing back-up power supplies for intermittent renewable resources like solar and wind power. Because the sun can unexpectedly go behind a cloud or the wind can die down, intermittent renewables need back up power sources that can quickly ramp up or ramp down depending on grid demands and generation at renewable power installations.

Despite these unique benefits and the fact that hydroelectric generation was a key component in the formulation and approval of many of California's water systems, accounting for hydroelectric generation in energy intensity calculations is complex. In some systems like the SWP and Central Valley Project, water generates electricity and then flows back into the natural river channel after passing through the turbines. In systems like the Mokelumne aqueduct, water can leave the reservoir by two distinct outflows, one that generates electricity and flows back into the natural river channel and one that does not generate electricity and flows into a pipeline flowing into the East Bay Municipal Utility District service area. In both these situations, experts have argued that hydroelectricity should be excluded from energy intensity calculations because the energy generation system and the water delivery system are in essence separate (Wilkinson 2000).

DWR has adopted this convention for the energy intensity for hydropower in the regional reports. All hydroelectric generation at head reservoirs has been excluded from Figure CR-19. Consistent with Wilkinson (2000) and others, DWR has included in-conduit and other hydroelectric generation that occurs as a consequence of water deliveries, such as the Los Angeles Aqueduct's hydroelectric generation at San Francisquito, San Fernando, Foothill, and other power plants on the system (downstream of the Owen's River Diversion Gates). DWR has made one modification to this methodology to simplify the display of results: Energy intensity has been calculated at each main delivery point in the systems; if the hydroelectric generation in the conveyance system exceeds the energy needed for extraction and conveyance, the energy intensity is reported as zero (0). That is, no water system is reported as a net producer of electricity, even though several systems do produce more electricity in the conveyance system than is used (e.g., Los Angeles Aqueduct, Hetch Hetchy Aqueduct). (For detailed descriptions of the methodology used for the water types presented, see *Technical Guide, Volume 5*).

FOOTNOTE: The WRCC has temperature and precipitation data for the past century. Through an analysis of National Weather Service Cooperative Station and PRISM Climate Group gridded data, scientists from the WRCC have identified 11 distinct regions across the state for which stations located within a region vary with one another in a similar fashion. These 11 climate regions are used when describing climate trends within the state (Abatzoglou, et al. 2009). DWR's hydrologic regions, however, do not correspond directly to WRCC's climate regions. A particular hydrologic region may overlap more than one climate region and, hence, have different climate trends in different areas. For the purpose of this regional report, climate trends of the major overlapping climate regions are considered to be relevant trends for respective portions of the overlapping hydrologic region.